

### REMARKS

Claims 1-311 were pending in the Application prior to the amendments herein.

Claims 1-311 are rejected.

Claims 33, 105, 175, 227, 230, 236-239 and 265 are amended herein. The amendments to claims 33, 105, 175, 227, and 265 correct typographical errors. The amendment to claim 230 is supported in original claim 235. The amendments to claims 236-239 correct the claim dependencies in view of the amendment to claim 230.

Claims 220 and 235 are cancelled herein.

Claims 1-219, 221-234 and 236-311 are pending after entry of the amendments herein.

#### 1. Rejections Under 35 U.S.C. § 102(e) as Being Anticipated by Resasco

The Examiner has rejected Claims 1-4, 220 and 230-234 under 35 U.S.C. § 102(e) as being anticipated by Resasco et al., U.S. Patent 6,333,016 ("*Resasco*"). Office Action at 2.

Regarding Claims 1-4, 220 and 230-234, the Examiner contends that "*Resasco et al.* teaches producing single-wall carbon nanotubes using metal catalysts with a metal from group VIB and group VIII on a support of magnesium oxide and reacting it with a carbon containing gas stream." Office Action at 2.

Applicant respectfully traverses the rejection.

Anticipation requires each and every element of the claim to be found within the cited prior art reference.

Claim 1 requires, *inter alia*, that the catalytic metal comprises iron (Fe). *Resasco* does not teach a catalyst comprising iron. In fact, and, in contrast to Claim 1 of the present invention,

the catalyst of *Resasco* specifically excludes iron. See column 2, lines 65-67 and column 3, lines 1-8:

According to the present invention, a method for producing carbon nanotubes is provided which avoids the defects and disadvantages of the prior art. Broadly, the method includes contacting, in a reactor cell, metallic catalytic particles with an effective amount of a carbon-containing gas at a temperature sufficient to catalytically produce carbon nanotubes, wherein a substantial portion of the carbon nanotubes are single-walled carbon nanotubes, and the metallic catalytic particle includes a Group VIII metal, excluding iron, and a Group VIb metal.

(Emphasis added.)

Thus, *Resasco* teaches away from the invention of Claim 1.

Claim 1 also requires, *inter alia*, that the "catalyst has been prepared by combusting." *Resasco* does not teach or suggest preparing a catalyst by combusting. Rather, *Resasco* teaches the preparation of a catalyst by simple mixing of two metals, decomposing metallic precursor compounds or, in the case of a supported catalyst, depositing metals on a support by metal evaporation or incipient wetness impregnation of metal compounds. (See column 5, lines 25-40, and Example 1.)

Thus, *Resasco* does not teach each and every element of Claim 1. Therefore, Applicant respectfully asserts that Claim 1 is not anticipated by *Resasco*.

With regard to Claims 2-4, Claims 2-4 are directly dependent upon Claim 1 and are not anticipated by *Resasco* for the same reasons that Claim 1 is not anticipated by *Resasco*.

Claim 220 has been cancelled, and therefore the rejection is moot as to this claim.

Claim 230 has been amended to include the element of Claim 235, "wherein the catalyst is prepared by combusting a combination of Group VIIIB metal precursors, Group VIB metal precursors and refractory particle precursors." *Resasco* does not teach a catalyst made by combusting, let alone a catalyst prepared by combusting a combination of Group VIIIB metal

precursors, Group VIB metal precursors and refractory particle precursors. Thus, *Resasco* does not teach each and every element of amended Claim 230. Therefore, Applicant respectfully asserts that Claim 230, as amended, is not anticipated by *Resasco*. Claim 235 is cancelled herein. Claims 236-239, which depended from Claim 235, have been amended to depend from amended Claim 230.

Claims 231-234 are directly dependent upon amended Claim 230 and are not anticipated by *Resasco* for the same reasons that amended Claim 230 is not anticipated by *Resasco*.

Therefore, in light of the foregoing, Applicant respectfully requests that the Examiner withdraw his rejection of Claims 1-4 and 230-234 under 35 U.S.C. § 102(e) as being anticipated by *Resasco*.

## **2. Rejections Under 35 U.S.C. § 103(a) over *Resasco* in View of *Smalley***

The Examiner has rejected Claims 5-219 and 235-311 under 35 U.S.C. § 103(a) as being unpatentable over *Resasco et al.*, U.S. Patent 6,333,016 ("*Resasco*") in view of *Smalley et al.*, U.S. Patent 6,761,870 ("*Smalley*"). Office Action at 2.

Applicant respectfully traverses the rejections.

To establish a *prima facie* case of obviousness, at least three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference. Second, there must be a reasonable expectation of success. Finally, the prior art reference or references must teach or suggest all the claim limitations.

Furthermore, in ascertaining the differences between the cited prior art and the claim at issue, the Examiner must evaluate the claimed subject matter as a whole; there is no requirement

that the differences themselves be nonobvious. MPEP § 2141.02. The requisite view of the whole invention mandates consideration of not only its structure, but also of its properties and the problems solved. See MPEP § 2141.02. Further, the mere fact that the prior art can be modified does not make the modification obvious unless the prior art suggests the desirability of the modification; there must be some logical reason apparent from positive, concrete evidence that justifies the modification. See MPEP § 2143.01.

Claims 5-77 are dependent upon Claim 1 which requires, *inter alia*, "providing a supported catalyst of catalytic metal comprising iron (Fe) and molybdenum (Mo) on magnesium oxide (MgO) particles, wherein the catalyst has been prepared by combusting iron, molybdenum and magnesium oxide precursors to form the supported catalyst." Neither *Resasco* nor *Smalley*, either alone or in combination, teaches or suggests this element. The Examiner acknowledges that "*Resasco* does not teach the precursor steps." (Office Action at 3.) Furthermore, *Resasco* does not teach or suggest making a catalyst by combustion, nor does *Resasco* teach or suggest a catalyst which includes iron. As discussed above, *Resasco* teaches away from Claim 1 by specifically excluding iron from the catalyst. Also, in contrast to Claim 1, *Smalley* does not teach, suggest or provide motivation for a catalyst comprising a support. Furthermore, *Smalley* does not teach, suggest or provide motivation for a catalyst made by combustion, nor does *Smalley* teach precursors for catalysts made by combustion. (See *Smalley* at column 6, lines 1-53.) Therefore, there is no teaching, suggestion or motivation to modify the teachings of *Resasco* with that of *Smalley* to arrive at the presently claimed invention. Furthermore, even if the teachings of *Resasco* and *Smalley* were combined, they would not teach or suggest all the claim limitations. Thus, a case of *prima facie* obviousness has not been established as to Claims 5-77, which depend on Claim 1.

Claims 78 and 150 require, *inter alia*, the step of "sulfiding the catalyst." The Examiner acknowledges that *Resasco* does not teach "sulfiding the catalyst." (Office Action at 3.) *Smalley* does not teach sulfiding a catalyst either. *Smalley* teaches a catalyst formed *in situ* from the decomposition of metal-containing compounds in a reactor in which single-wall carbon nanotubes are formed. *Smalley* teaches the forming of catalysts by the aggregation of metal atoms in the reactor for making single-wall carbon nanotubes, and also teaches catalyst promoters, which are added to a CO feedstock. Such promoters, besides thiophene and H<sub>2</sub>S, include volatile lead and bismuth compounds. See *Smalley* at column 13, ll. 1-4. One of ordinary skill in the art would not consider addition of a catalyst promoter to a feedstock gas that is injected into a reactor wherein a catalyst is formed *in situ* the equivalent of a step of sulfiding a catalyst. Thus, since *Smalley* does not teach or suggest a supported catalyst, *Smalley* cannot and does not teach or suggest the sulfiding of a supported catalyst.

Both claims 78 and 150 require, *inter alia*, a catalyst support. Claim 78 requires a catalyst support comprising "a support selected from the group consisting of alumina, magnesia, silica, zirconia and combinations thereof." Claim 150 requires magnesium oxide particles, which are a catalyst support. As stated above, *Smalley* does not teach a catalyst which includes a support.

There is no suggestion or motivation in either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the teachings of *Resasco* with that of *Smalley* to arrive at the invention claimed in Claims 78 or 150. Even if the teachings of *Resasco* and *Smalley* were combined, there is no reasonable expectation of success, given the very real possibility in the unpredictable catalyst art that the modification of the prior art proposed by the Examiner could result in poisoning or deactivating the catalyst.

Furthermore, even if the teachings of *Resasco* and *Smalley* were combined, they would not teach or suggest all the claim limitations. Thus, a case of *prima facie* obviousness has not been established for Claims 78 and 150.

Claims 79-149 and 151-219 are dependent, either directly or indirectly, from upon Claims 78 and 150, respectively, and are not *prima facie* obvious for the same reasons that Claims 78 and 150 are not *prima facie* obvious.

With regard to Claim 235, this claim is cancelled herein and, therefore, rejection of Claim 235 is now moot.

Claims 236-311 are dependent upon Claim 230 which has been amended, as stated above, to include the element "wherein the catalyst is prepared by combusting a combination of Group VIIIB metal precursors, Group VIB metal precursors and refractory particle precursors." *Resasco* does not teach, suggest or provide motivation to produce a catalyst made by combusting, let alone a catalyst prepared by combusting a combination of Group VIIIB metal precursors, Group VIB metal precursors and refractory particle precursors. As stated above, *Smalley* does not teach, suggest or provide motivation to provide a catalyst comprising a support. Furthermore, *Smalley* does not teach, suggest or provide motivation for making a catalyst by combustion, nor does *Smalley* teach precursors for making catalysts made by combustion. Therefore, there is no suggestion or motivation to modify the teachings of *Resasco* with those of *Smalley* to arrive at the presently claimed invention. Furthermore, even if the teachings of *Resasco* and *Smalley* were combined, they would not teach or suggest all the claim limitations. Thus, a case of *prima facie* obviousness has not been established for Claim 230, as amended.

Claims 235-311 are dependent, directly or indirectly, on amended Claim 230 and are not *prima facie* obvious for the same reasons that Claim 230, as amended, is not *prima facie* obvious.

Therefore, in light of the foregoing, Applicant respectfully requests that the Examiner withdraw his rejection of Claims 5-219 and 235-311 under 35 U.S.C. § 103(a) as being unpatentable over *Resasco* in view of *Smalley*.

### 3. Rejections Under 35 U.S.C. § 103(a) over *Resasco*

The Examiner has rejected Claims 221-223 and 227-229 under 35 U.S.C. § 103(a) as being unpatentable over *Resasco et al.*, U.S. Patent 6,333,016 ("*Resasco*") as applied to Claims 1, 220 and 230, above. Office Action at 3.

Examiner contends that "*Resasco* does not teach using fluidizing aid particles. It would have been obvious to anyone of ordinary skill in the art to use fluidizing particles to enhance the fluidization of a fluidized bed reactor." *Id.*

It is incumbent on the Examiner to cite a prior art reference that teaches or suggests such use of fluidizing particles. Absent such a reference, this rejection is improper and should be withdrawn. Prior art to support a rejection cannot be replaced by general, conclusory statements. *In re Thrift*, 298 F.3d 1357, 63 U.S.P.Q.2d 2002, 2006-08 (Fed. Cir. 2002); *In re Lee*, 277 F.3d 1338, 1344, 61 U.S.P.Q.2d 1430, 1434 (Fed. Cir. 2002).

Furthermore, Claim 221 requires, *inter alia*, "feeding the supported catalyst, a carrier gas, a carbon-containing feedstock gas and fluidizing aid particles to a fluidized bed reactor." Besides not teaching, suggesting or providing motivation for fluidizing aid particles, *Resasco* also does not teach, suggest or provide motivation for a method using a fluidized bed

Thus, a case of *prima facie* obviousness has not been established for Claim 221.

Claims 222-223 are dependent on Claim 221 and are not *prima facie* obvious for the same reasons that Claim 221 is not *prima facie* obvious.

Claim 227 requires, *inter alia*, "feeding the supported catalyst, a carrier gas, a carbon-containing feedstock gas and fluidizing aid particles to a reactor, wherein the fluidizing aid particles generally flow in substantially the same direction as the carrier gas and the carbon-containing feedstock gas in the reactor." Claim 227 further requires "withdrawing a product stream from the reactor that comprises single-wall carbon nanotubes, and fluidizing aid particles; and separating the single-wall carbon nanotubes from the fluidizing aid particles." As discussed above, *Resasco* does not teach, suggest or provide motivation for a method using fluidizing aid particles in a reactor, or "withdrawing a product stream from the reactor that comprises single-wall carbon nanotubes, and fluidizing aid particles; and separating the single-wall carbon nanotubes from the fluidizing aid particles." Thus, a case of *prima facie* obviousness has not been established for Claim 227.

Claims 228-229 are dependent on Claim 227 and are not *prima facie* obvious for the same reasons that Claim 227 is not *prima facie* obvious.

Therefore, Applicant respectfully requests that the Examiner withdraw his rejection of Claims 221-223 and 227-229 under 35 U.S.C. § 103(a) as being unpatentable over *Resasco* as applied to Claims 1, 220 and 230.

#### 4. Rejections Under 35 U.S.C. § 103(a) over *Resasco* in View of Yamada

The Examiner has rejected Claims 224-226 under 35 U.S.C. § 103(a) as being unpatentable over *Resasco et al.*, U.S. Patent 6,333,016 ("*Resasco*") as applied to Claims 1, 220

and 230 above, in view of Yamada et al. (U.S. Patent 5,102,647) ("*Yamada*"). Office Action at 4.

The Examiner contends that "[n]either *Resasco* nor *Smalley* teach injecting the catalyst into the reactor counter-current to the flow of the gas streams. *Yamada* et al., however, does teach using a counter-current flow of catalyst particles (Column 3, lines 58-62). It would have been obvious to someone of ordinary skill in the art to use a counter-current flow method in order to increase the contact efficiency of the reactants and catalyst particles. It is also obviousness to anyone of ordinary skill in the art to use fluidizing particles to enhance the fluidization of a fluidized bed reactor." *Id.*

Claim 224 requires, *inter alia*, "continuously feeding the supported catalyst, a carrier gas, a carbon-containing feedstock gas and fluidizing aid particles to a reactor, wherein the fluidizing aid particles generally flow generally counter-current to the carrier gas and carbon-containing feedstock gas in the reactor." Claim 224 further requires "withdrawing an upper product stream from the reactor that comprises single-wall carbon nanotubes, and separately withdrawing a lower product stream from the reactor that comprises fluidizing aid particles." As discussed above, *Resasco* does not teach, suggest or provide motivation for a method using fluidizing aid particles in a reactor, let alone "wherein the fluidizing aid particles generally flow generally counter-current to the carrier gas and carbon-containing feedstock gas in the reactor," or further requiring "withdrawing an upper product stream from the reactor that comprises single-wall carbon nanotubes, and separately withdrawing a lower product stream from the reactor that comprises fluidizing aid particles."

*Yamada* teaches a method of producing vapor growth carbon fibers using transition metal fine particles as a catalyst and ceramic granules in the reaction space. The Examiner points to

the mention of countercurrent flow at column 3, lines 58-62 of *Yamada*. However, in contrast to Claim 224, *Yamada* does not teach, suggest or provide motivation for "a method for producing single-wall carbon nanotubes, comprising providing a supported catalyst comprising at least one metal from the group consisting of Group VIB and Group VIIB." Furthermore, there is no motivation to combine *Resasco* and *Yamada*. *Yamada* relates to production of carbon fibers, while *Resasco* teaches the production of carbon nanotubes, a different type of product. A person of ordinary skill would not look to *Yamada* for ideas as to how to improve the process of *Resasco*.

As there is no suggestion or motivation, taken without the benefit of hindsight reasoning, either in *Resasco* or in *Yamada*, to combine the references, a *prima facie* case of obviousness has not been established for Claim 224.

Claims 225-226 are dependent on Claim 224 and are not *prima facie* obvious for the same reasons that Claim 224 is not *prima facie* obvious.

Therefore, Applicant respectfully requests that the Examiner withdraw his rejection of Claims 224-226 under 35 U.S.C. § 103(a) as being unpatentable over *Resasco* as applied to Claims 1, 220 and 230 above in view of *Yamada*.

## 5. Claim Amendments

Claims 33, 105, 175 and 265 are amended herein to correct the spelling of "gaseous." Claim 227 is amended herein at step (d) to correct a grammatical error. No new matter has been added by virtue of these amendments.

**6. Conclusion**

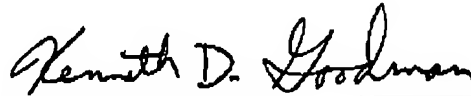
As a result of the foregoing, Applicant asserts that the Claims are now in condition for allowance.

The Examiner is invited to contact the undersigned attorney at (713) 934-4094 with any questions, comments or suggestions relating to the referenced patent application.

Respectfully submitted,

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